# DESIGNING AND FABRICATION OF RACKET TEST RIG.

SURAJ s/o VIJANATHAN

Report submitted in partial fulfillment of the requirements for the award of
Diploma of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

JUNE 2013

## ABSTRACT

This thesis deals with the designing and fabrication of racket test rig. Test rig is a useful device as it is an apparatus used for assessing the performance of a piece of mechanical equipment. The main objective of this final year project is to design and fabricate a racket test rig for further study of the performance of a racket. This thesis describes the methods of designing and fabricating the mechanical part of the test rig. There are many steps taken to design and fabricate the mechanical parts of this test rig. The structural three-dimensional solid modeling of the test rig was developed by using the SolidWorks engineering drawing software. The fabrication process also undergoes many steps such as material marking, cutting, drilling, welding, milling, turning, grinding and finishing of the test rig by painting. The results of the testing of the performance of racket and how far the shuttlecock can reach with certain applied force and angle on the racket also discussed in this thesis.

## ABSTRAK

Tesis ini membincangkan tentang mereka bentuk dan fabrikasi pelantar ujian raket. Pelantar ujian adalah alat yang berguna kerana ia adalah satu alat yang digunakan untuk menilai prestasi sebuah peralatan mekanikal. Objektif utama projek tahun akhir ini adalah, untuk mereka bentuk dan memfabrikasikan suatu pelantar ujian raket untuk kajian selanjutnya tentang prestasi raket. Tesis ini juga menerangkan kaedah mereka bentuk dan pembuatan setiap bahagian mekanikal pelantar ujian tersebut. Terdapat beberapa langkah yang diambil untuk mereka bentuk dan membuat bahagian-bahagian mekanikal pelantar ujian ini. Pemodelan tiga dimensi struktur pelantar ujian telah dibuat dengan menggunakan SolidWorks yang merupakan perisian lukisan kejuruteraan. Proses fabrikasi juga mengalami banyak langkah seperti menanda, memotong, penggerudian, kimpalan, “milling”, “turning”, pengisaran dan kemasan pelantar ujian dengan cat. Keputusan ujian prestasi raket dengan sejauh bulu boleh mencapai dengan kuasa tertentu digunakan dan sudut pada raket juga dibincangkan dalam tesis ini.

# TABLE OF CONTENT

**Page**

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF SYMBOLS

| | |
|---|---|
| Kg | Kilogram |
| m | Meter |
| MPa | Megapascals |
| Rpm | rotation per minute |
| mm | Milimeter |
| Ø | Diameter |
| R | Radius |
| Psi | pounds per square inch |
| d | diameter |
| $\pi$ | Pi (3.1242) |

# LIST OF ABBREVIATION

| | |
|---|---|
| UMP | Universiti Malaysia Pahang |
| MASUM | Majlis Sukan Universiti Malaysia |
| SMAW | Shielded Metal Arc Welding |
| GMAW | Gas Metal Arc Welding |
| MIG | Metal Inert Gas |
| PPE | Personal Protective Equipment |
| 3D | Three Dimension |

# CHAPTER 1

# INTRODUCTION

## 1.1.1 INTRODUCTION

A racket or racquet is a sports implement consisting of a handled frame with an open hoop across which a network of cord is stretched tightly. It is used for striking a ball in such games as squash, tennis, racquetball, and badminton. Collectively, these games are known as racquet sports.

The frame of rackets for all sports was traditionally made of laminated wood and the strings of animal intestine known as catgut. The traditional racket size was limited by the strength and weight of the wooden frame which had to be strong enough to hold the strings and stiff enough to hit the ball or shuttle. Manufacturers started adding non-wood laminates to wood rackets to improve stiffness. Non-wood rackets were made first of steel, then of aluminum, and then carbon fiber composites. Wood is still used for real tennis, rackets, and xare. Most rackets are now made of composite materials including carbon fiber, fiberglass, metals such as titanium alloys or ceramics. Gut has partially been replaced with synthetic materials including nylon, polyamide, and other polymers. Rackets are restrung when necessary, which may be after every match for a professional or never for a social player.

A racket base game is mostly just the same where we should hit the object coming towards us with the racket. In my project I focused more into the swinging hitting method as most of the racket game r played by swinging to hit the object.

## 1.2 PROBLEM STATEMENT

Many of the existing racket test rig doesn't have any machine that tests a racket by using a swinging method. Most of the machine built is to test the string band of the racket and also the strength of the racket itself. Plus it is hard to determine the actual hitting power of the racket without using the swinging method. The reason is that during any racket game is played the will be an error where the players will hit the object such as the shuttlecock with the frame of the racket.

## 1.3 OBJECTIVE

From the problem statement an objective had had been done which is to design and fabricate a racket test rig that can test the hitting force, angle and the distance of the shuttlecock after hitting from the racket by using swinging method.

## 1.4 PROJECT SCOPE

i. To design 3D racket test rig by using SolidWorks.

ii. Material used for the design:

iii. To fabricate a portable racket test rig by using materials such as stainless steel (round hollow & metal sheet) , aluminum (solid &metal sheet) , and mild steel (square hollow)

iv. To fabricate an adjustable height, angle and force for the racket test rig.

# CHAPTER 2

# LITERATURE REVIEWS

## 2.1 INTRODUCTION

The title “Designing & Fabricating Racket Test Rig” requires an amount of good understanding on the knowledge of types of rackets especially badminton racket as it has been the main reason for this project. Therefore, executing a research is necessary to obtain all the relevant and useful information that are available and related to this project. The information or literature reviews obtained are essentially valuable to assist in the fabrication and specification of this final year project. With this ground established, the project can be accomplished with guidance in achieving the target mark.

In the same view, swinging method is a method that use in most racket based games to play. For example in badminton sports, the racket is swing by the player to hit the object (shuttlecock) that coming towards him so that the object can go back to the opposite direction with the impact of collision cause between the object and the racket. This also happens in other racket based sports such as tennis, squash and ping pong. Figure 2.1 shows the parts of a racket badminton.

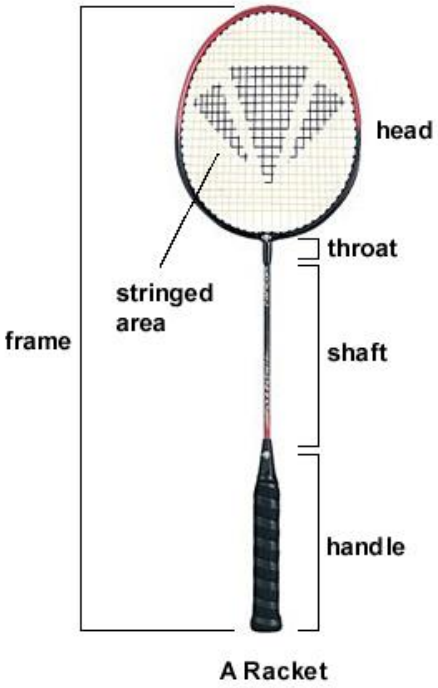


**Figure 2.1:** Parts of a badminton racket

**Source:** www.badminton-information.com

## 2.2 TYPES OF EXISTING RACKET TEST RIG.

### 2.2.1 Rebound Impact Testing Machine (ZME-1601)

Feather bat and net bat rebound impact testing machine is mainly use for badminton and tennis racket rebound test. It is also an ideal tester to produce result on the impact that occurs between the string band of the racket and the shot towards it such as shuttlecock or tennis ball. The shooting speed of this machine can go up to a maximum hitting speed of 200km/h. This machine is expensive due to the sensors, air compressor and more. The price of this rebound impact testing machine can cost from US $200 and up to US$ 5,000 per set based on the specification that we require.

This machine functions by clamping the head of the racket at the clamping area and the specific object such as the shuttlecock or a tennis ball to be shot is put in to the

launching area. The air is compressed by the air compressor and we can set the hitting speed of the object towards the stringed area of the racket.

With a push of a single button at the control box the object will be shot towards the racket and the sensors will take the reading of the impact and show at the screen located at the control box. Figure 2.2 shows the rebound impact testing machine.

**Figure 2.2:** Feather Bat And Net Bat Rebound Impact Testing Machine (ZME-1601)

**Source:** http://www.gotech.biz

### 2.2.2 Racket Pressure Tester (ZME-1602)

This Racket Pressure Tester (ZME-1602) is a machine used to test the loading force applied on the racket. Other than that, this machine also functions to test the deformation range and ratio of the racket itself when pressure is applied on it. Plus, this racket pressure tester machine is mainly used for inspecting the deformation of net bat when it is set on the pivot point and then the force or pressure is applied with a constant speed. The speed of the pressure applying arm set from 0mm and up to 1000 mm/min. The force applying arm can travel from 0mm to 300mm with a range of punch tip of φ20 × 470 mm. This machine weigh 100kg and it is not a moveable machine. The price is also expensive where it can cost from US$ 200 to US$ 5000 based on the specification or function that we require.

Racket pressure tester function by putting the racket the table and set the travelling distance of the pressure applying arm. The travelling speed need to be set within the suggested range. The pressure applying arm will move upwards n downwards with a constant speed as we set it before at the controlling box. The reading of the loading force applied on the racket will be printed out by a printer located next to the controlling box. The reading of pressure applied is determined by the pressure applying arm where it will take the reading of the force that opposes it cause by the racket. Figure 2.3 shows the racket pressure tester.

**Figure 2.3:** Racket Pressure Tester (ZME-1602)

**Source:** http://www.gotech.biz

### 2.2.3 Racket Twisting Strength Tester (GT-7074- AD)

This machine is designed to determine the resistance of badminton racket and tennis racket to twist. A racket is tested in such a manner that the handle is fixed and a given torsion or torsion angle is applied. The torsion sensor detects the torsion and the rotary encoder detects the angle. Together with the U25 controller, it returns to the zero point to check the damage of the racket. Figure 2.4 shows the machine.

This machine uses the accurate torsion sensor and rotary encoder to accurately detect the torsion and rotation angle. The U25 controller is used for controlling the test system so that you can set test conditions as you wish. It is convenient to clamp the specimen. The torsion speed can be set to a given range, and the torsion direction can be set based on your test requirements. Table 2.1 shows the features and specification of racket twisting strength tester.

**Table 2.1:** Features and Specification of GT-7074-AD Racket Twisting Strength Tester

**Source:** http://www.gotech.biz

| **Features** | **Specifications** |
|---|---|
| Indicator | U25 (can display torsion , angle, rotation rate of angle) |
| Capacity | 100 N |
| Max. torsion angle | ±35° |
| Torsion speed | 90~180 °/min |
| Angle resolution | 0.1° |
| Force resolution | 1/50,000 |
| Distance between the clamped position and the head of the racket frame | 110±5mm |
| Dimension | (W × D × H ) 160×60×106 cm |
| Weight | 103 kg |
| Power | 1ϕ , AC 220V, 50/60 Hz (Specified by user ) |


**Figure 2.4:** Racket Twisting Strength Tester (GT-7074-AD )

**Source:** http://www.gotech.biz

### 2.2.4 Racket Drop Tester (GT-7066-A )

This racket drop tester machine is designed for determining the resistance of a racket to impact. The racket handle is fixed to the clamping device. Use the electromagnet to release the racket when the clamping device is at the top. After the racket along with the clamping device drops naturally, examine if the frame of the racket is damaged. The clamping device moves up and down automatically controlled by this machine. The sensitive photoelectric sensor plus various counterweights can meet the specified requirements. Figure 2.5 shows the machine.

The price of this test rig is in the range between US$ 600 to US$ 800. It is also a non-moveable machine. Table 2.2 shows the features and specifications of the racket drop tester.

**Table 2.2:** Specification of GT-7066-A Racket Drop Tester

**Source:** http://www.gotech.biz

| Features | Specifications |
|---|---|
| Test height | 1800mm (from frame top to base) |
| Base thickness | 12mm |
| Load | 500g (Including racket) |
| Drop method | Electromagnetic release |
| Dimension | (W × D × H ) 40 × 50 ×350 cm |
| Weight | 130 kg |
| Power | 1ϕ , AC 220V, 50/60 HZ （Specified by user） |

**Figure 2.5:** Racket Drop Tester (GT-7066-A)

**Source:** http://www.gotech.biz